NACA

RESEARCH MEMORANDUM

for the

Bureau of Aeronautics, Department of the Navy

WIND-TUNNEL INVESTIGATION AT LOW SPEED OF STATIC AND YAWING CHARACTERISTICS OF A 0.085-SCALE MODEL OF THE CHANCE VOUGHT XF8U-1 AIRPLANE

TED NO. NACA DE 392

By Byron M. Jaquet and James L. Williams

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Langley Field, Va.

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS
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SUMMARY

At the request of the Bureau of Aeronautics, Department of the Navy, an investigation was made in the Langley stability tunnel in order to determine the low-speed yawing derivatives of a 0.085-scale model of the Chance Vought XF8U-1 airplane and, in addition, to determine the static longitudinal and static lateral stability characteristics in order to provide a basis for a comparison of the present data with data from other sources for slightly different model configurations. The complete model was tested through an angle-of-attack range of -6° to 36° in three clean configurations and one landing configuration; and with horizontal and vertical tails off for one clean configuration and the landing configuration. Tests were also made to determine the effects of external stores and horizontal-tail incidence on the derivatives of the complete model. In order to expedite publication, no analysis of the data has been made.

INTRODUCTION

In the development of an airplane, it is necessary to have an accurate knowledge of the stability derivatives and mass characteristics in order to insure accurate estimates of the dynamic stability. Although various techniques are available to enable estimates of derivatives to be made (ref. 1) previous experience has indicated that for a specific airplane wind-tunnel tests of a model are necessary in order to obtain accurate derivatives through a large angle-of-attack range. (See ref. 2, for example.)

As an aid in the development program of the Chance Vought XF8U-1 airplane, the present investigation, made in the Langley stability tunnel, was requested by the Bureau of Aeronautics, Department of the Navy. The purpose of this investigation was to determine the yawing derivatives of a 0.085-scale model of the Chance Vought XF8U-1 airplane and, in addition, to determine the static longitudinal and static lateral stability characteristics in order to provide a basis for a comparison of the present data with data from other sources for slightly different model configurations. The complete model was tested in three clean configurations and one landing configuration and with the horizontal and vertical tails off for one clean configuration and the landing configuration through an angle-of-attack range of -6° to 36°. Tests were also made in order to determine the effects of external stores and horizontal-tail incidence on the derivatives of the complete model.

SYMBOLS

The data presented herein are in the form of standard NACA symbols and coefficients of forces and moments and are referred to the stability system of axes shown in figure 1. The coefficients are based on the dimensions of the wing plan form neglecting the chord-extension. The center of gravity was located at 0.287 mean aerodynamic chord. The symbols and coefficients used herein are defined as follows:

L	lift, lb
D	drag, lb
Y	lateral force, lb
L'	rolling moment, ft-lb
M	pitching moment, ft-lb
N	yawing moment, ft-lb
A	aspect ratio, b^2/S
b	span, ft
S	area, sq ft
c	local chord parallel to plane of symmetry, ft
$\bar{c}$	mean aerodynamic chord, $\frac{2}{S}\int_0^{b/2} c^2 dy$, ft

y	spanwise distance measured from and perpendicular to plane of symmetry, ft
l	tail length, distance parallel to fuselage reference line from center of gravity to $\bar{c}/4$ of tail, ft
z	tail height, vertical distance from center of gravity to $\bar{c}/4$ of tail measured perpendicular to fuselage reference line, ft
q_o	dynamic pressure, $\rho V^2/2$, lb/sq ft
ρ	mass density of air, slugs/cu ft
V	airspeed, ft/sec
V'	volume, cu ft
α	angle of attack of fuselage reference line, deg
i_W	angle of incidence of wing with respect to fuselage reference line, deg
i_H	angle of incidence of horizontal tail with respect to fuselage reference line, deg
δ_f	symmetrical deflection of wing trailing-edge control, measured perpendicular to hinge line, deg
$\delta_{I.L.E.}$	deflection of inboard wing leading edge, deg (See fig. 2.)
$\delta_{O.L.E.}$	deflection of outboard wing leading edge, deg (See fig. 2.)
β	angle of sideslip, deg
ψ	angle of yaw, deg
$rb/2V$	yawing-angular-velocity parameter, radian
r	yawing angular velocity, radians/sec, $d\psi/dt$
C_L	lift coefficient, L/q_oS_W
C_D	drag coefficient, D/q_oS_W
C_Y	lateral-force coefficient, Y/q_oS_W

C_l rolling-moment coefficient, $L'/q_o S_W b_W$

C_m pitching-moment coefficient, $M/q_o S_W \bar{c}_W$

C_n yawing-moment coefficient, $N/q_o S_W b_W$

$$C_{Y_\beta} = \frac{\partial C_Y}{\partial \beta}$$

$$C_{n_\beta} = \frac{\partial C_n}{\partial \beta}$$

$$C_{l_\beta} = \frac{\partial C_l}{\partial \beta}$$

$$C_{Y_r} = \frac{\partial C_Y}{\partial \frac{rb}{2V}}$$

$$C_{n_r} = \frac{\partial C_n}{\partial \frac{rb}{2V}}$$

$$C_{l_r} = \frac{\partial C_l}{\partial \frac{rb}{2V}}$$

Subscripts:

W wing

V vertical tail

H horizontal tail

Notation: For convenience, the model components are denoted by the following symbols:

W wing

F fuselage

V vertical tail

H horizontal tail

APPARATUS AND MODEL

The 6- by 6-foot curved-flow test section (ref. 3) of the Langley stability tunnel was used for the present investigation. In this test section curved flight is simulated by curving the airstream about a rigidly mounted model. The model was mounted on a single support strut which was rigidly attached to a six-component balance system.

The model used in the present investigation was a 0.085-scale model of the Chance Vought XF8U-1 airplane and was supplied to the NACA by Chance Vought Aircraft. The general arrangement of the model is shown in figure 2. Additional details are given in table I and photographs of the model are presented as figure 3. The chordwise gaps at the inboard edge of the deflectable leading edge, at the inboard edge of the deflectable chord-extension, and along the trailing-edge control were unsealed for the tests as were the spanwise gaps along the trailing-edge control. The trailing-edge control was only used as a flap for the present investigation although it is both a flap and an aileron. For all tests, the spanwise gaps along the hinge line of the deflectable leading edge were sealed on the upper and lower surfaces with plastic tape. The various model configurations tested are indicated in the following table:

Model configuration	i_W, deg	i_H, deg	$\delta_{I.L.E.}$, deg	$\delta_{O.L.E.}$, deg	δ_f, deg	Components	Stores
Clean	-1	0	0	0	0	WFVH	Off
	-1	0	0	6.8	0	WFVH	Off
	-1	0	6.8	6.8	0	WFVH	Off
	-1	---	0	0	0	WF	Off
	-1	-10	0	0	0	WFVH	Off
	-1	0	0	0	0	WFVH	Inboard and outboard on
Landing	7	0	20	30	20	WFVH	Off
	7	---	20	30	20	WF	Off
	7	-10	20	30	20	WFVH	Off
	7	0	20	30	20	WFVH	Inboard and outboard on

TESTS

The tests consisted of six-component measurements through an angle-of-attack range of -6° to 36°. The test Mach number was 0.13 and the test Reynolds number was 0.93×10^6 based on a dynamic pressure of 24.9 lb/sq ft and the mean aerodynamic chord of the wing plan form neglecting the chord-extension ($\bar{c}_W = 1.001$ feet). The tests are summarized in the following table:

Test	β, deg	rb/2V
Static longitudinal	0	0
Static lateral	± 5	0
Yawing	0	0,-0.0316,-0.0670,-0.0882

CORRECTIONS

Approximate jet-boundary corrections derived for unswept wings (ref. 4) were applied to the angle of attack and drag coefficient. Blockage corrections were determined by the methods of reference 5 and were applied to the drag coefficient and dynamic pressure. Horizontal-tail-on pitching-moment coefficients were corrected for the effects of the jet boundaries by the methods of reference 6. The data are not corrected for the effects of the support strut.

In curved flow, a pressure gradient exists across the tunnel (ref. 3) and this necessitates the following corrections:

$$\Delta C_{Y_r} = \frac{4}{b_W S_W}\left[V_W' + V_V' + V_H' + V_F'(1 + 0.06 \cos^2\alpha + 1.92 \sin^2\alpha)\right]$$

$$C_{Y_r} = C_{Y_{r_T}} - \Delta C_{Y_r}$$

$$\Delta C_{l_r} = \Delta C_{Y_r} \frac{r'}{b_W} \sin(180^\circ - \alpha)$$

$$C_{l_r} = C_{l_{r_T}} - \Delta C_{l_r}$$

$$\Delta C_{n_r} = -\Delta C_{Y_r} \frac{r'}{b_w} \cos(180^\circ - \alpha)$$

$$C_{n_r} = C_{n_{r_T}} - \Delta C_{n_r}$$

where the subscript T refers to the uncorrected value of a given derivative. The corrections to C_{n_r} and C_{l_r} arise from the fact that the center of volume for this model does not coincide with the center of gravity but is 2 inches forward of the center of gravity and thus $r' = 1/6$ feet in the preceding equations.

RESULTS

Presentation of Results

The data of the present investigation are presented in figures 4 to 9 as follows:

Configuration	Data	Figure
Clean	C_L, C_D, and C_m plotted against α	4
Landing	C_L, C_D, and C_m plotted against α	5
Clean	C_{l_β}, C_{n_β}, and C_{Y_β} plotted against α	6
Landing	C_{l_β}, C_{n_β}, and C_{Y_β} plotted against α	7
Clean	C_{l_r}, C_{n_r}, and C_{Y_r} plotted against α	8
Landing	C_{l_r}, C_{n_r}, and C_{Y_r} plotted against α	9

The data are presented without analysis in order to expedite publication.

Langley Aeronautical Laboratory,
National Advisory Committee for Aeronautics,
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2. Jaquet, Byron M., and Fletcher, H. S.: Lateral Oscillatory Characteristics of the Republic XF-91 Airplane Calculated by Using Low-Speed Experimental Static and Rotary Derivatives. NACA RM L53G01, 1953.

3. Bird, John D., Jaquet, Byron M., and Cowan, John W.: Effect of Fuselage and Tail Surfaces on Low-Speed Yawing Characteristics of a Swept Wing Model as Determined in Curved-Flow Test Section of the Langley Stability Tunnel. NACA TN 2483, 1951. (Supersedes NACA RM L8G13.)

4. Silverstein, Abe, and White, James A.: Wind-Tunnel Interference With Particular Reference to Off-Center Positions of the Wing and to the Tail. NACA Rep. 547, 1936.

5. Herriot, John G.: Blockage Corrections for Three-Dimensional-Flow Closed-Throat Wind Tunnels, With Consideration of the Effect of Compressibility. NACA Rep. 995, 1950. (Supersedes NACA RM A7B28.)

6. Gillis, Clarence L., Polhamus, Edward C., and Gray, Joseph L., Jr.: Charts for Determining Jet-Boundary Corrections for Complete Models in 7- by 10-Foot Closed Rectangular Wind Tunnels. NACA WRL-123, 1945. (Formerly NACA ARR L5G31.)

TABLE I.- DETAILS OF 0.085-SCALE MODEL OF CHANCE VOUGHT XF8U-1 AIRPLANE

Wing:	
Airfoil section at root	65A006
Airfoil section at tip	65A005
Area, S_W, ft^2	2.715
Span, b_W, ft	3.043
Mean aerodynamic chord, $\bar{c}_W$, (without chord extension), ft	1.001
Root chord (on fuselage reference line), ft	1.430
Tip chord (without chord-extension), ft	0.352
Tip chord (with chord-extension), ft	0.394
Sweep of c/4, deg	42
Dihedral, deg	-5
Aspect ratio, A_W	3.4
Taper ratio, (without chord-extension)	0.25
Horizontal tail:	
Airfoil section at root	65A006
Airfoil section at tip	65A004
Area, S_H, sq ft	0.766
Span, b_H, ft	1.638
Root chord (on fuselage reference line), ft	0.814
Tip chord, ft	0.122
Sweep of c/4, deg	45
l_H, ft	1.56
Dihedral, deg	5.42
Area ratio, S_H/S_W	0.282
Aspect ratio	3.5
Taper ratio	0.15
Vertical tail:	
Airfoil section at root	65A006
Airfoil section at tip	65A004
Area, S_V, sq ft	0.722
Span, b_V, ft (measured from fuselage reference line)	1.028
Root chord (on fuselage reference line), ft	1.115
Tip chord, ft	0.291
Sweep of c/4, deg	45
l_V, ft	1.230
z_V, ft	0.412
Area ratio, S_V/S_W	0.266
Aspect ratio	1.47
Taper ratio	0.26

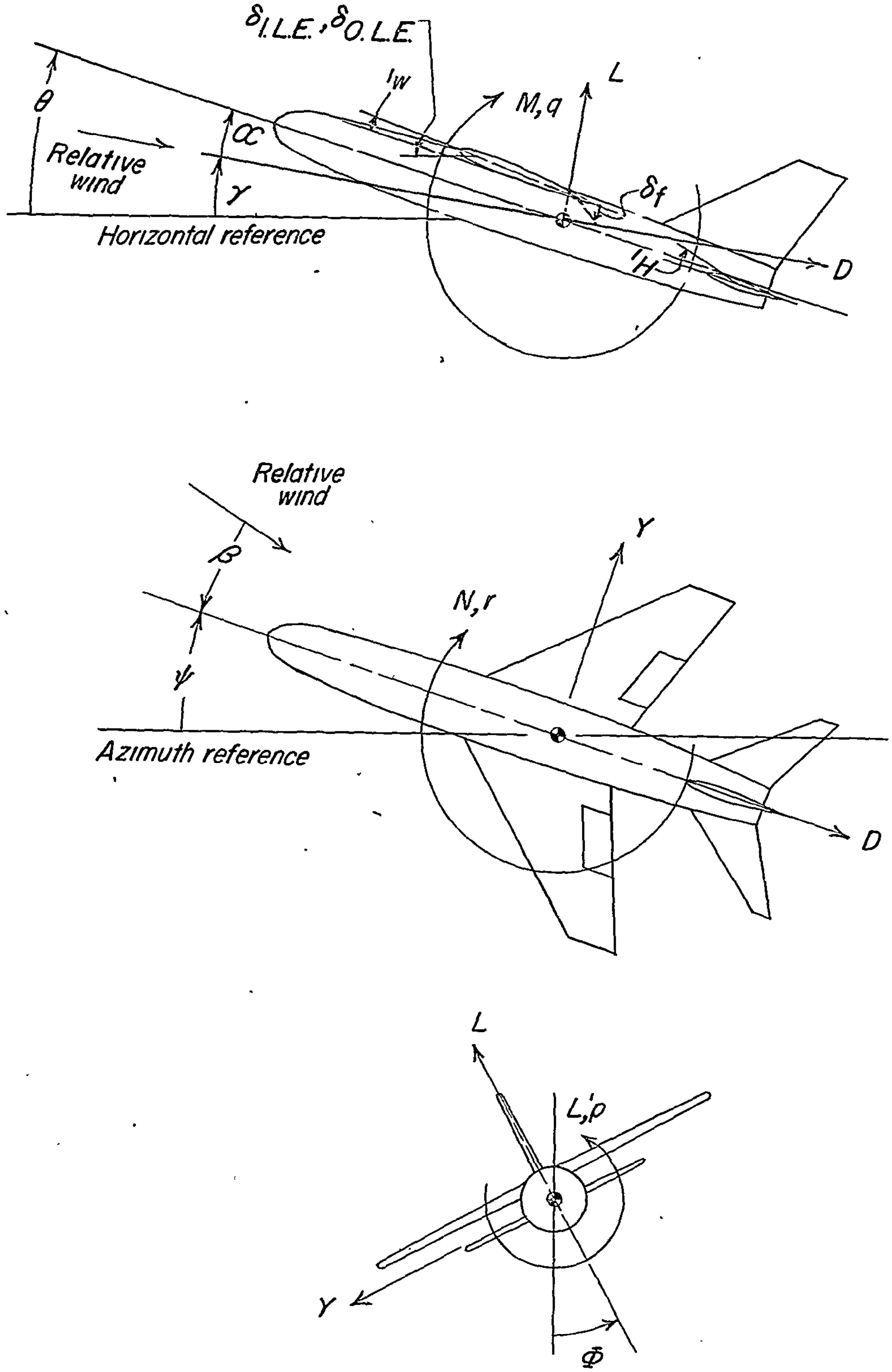

Figure 1.- Stability system of axes. Arrows indicate positive direction of forces, moments, angles, and angular velocities.

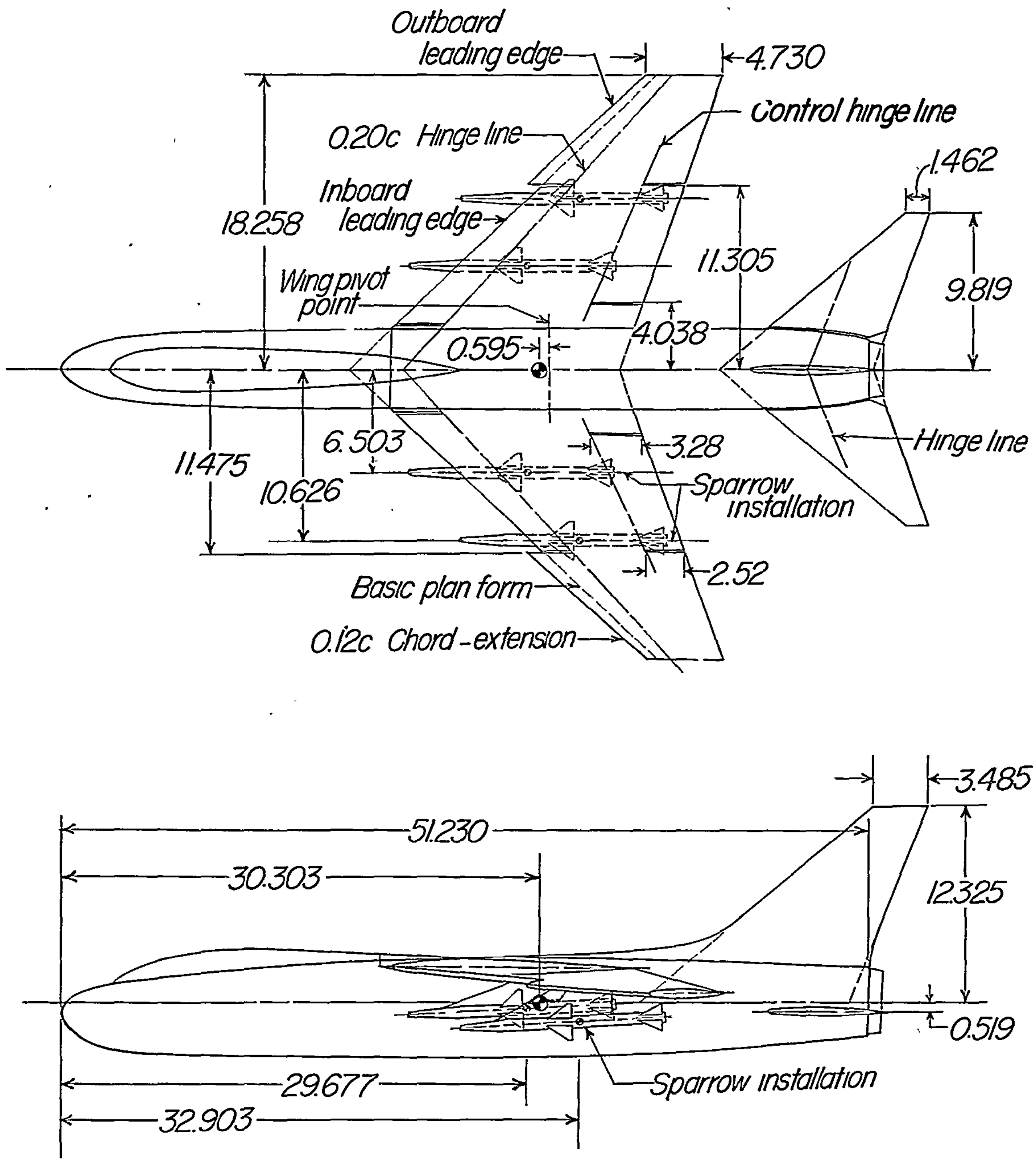

Figure 2.- Details of the 0.085-scale model of the Chance Vought XF8U-1 airplane. All dimensions are in inches.

L-82503

(a) Clean configuration. $i_W = -1^{\circ}$; $\delta_{I.L.E.} = 0^{\circ}$; $\delta_{O.L.E.} = 0^{\circ}$; $\delta_f = 0^{\circ}$.

L-82504

(b) Landing configuration. $i_W = 7^{\circ}$; $\delta_{I.L.E.} = 20^{\circ}$; $\delta_{O.L.E.} = 30^{\circ}$; $i_H = 0^{\circ}$; $\delta_f = 20^{\circ}$.

L-82506

(c) Landing configuration. $i_W = 7^{\circ}$; $\delta_{I.L.E.} = 20^{\circ}$; $\delta_{O.L.E.} = 30^{\circ}$; $i_H = 0^{\circ}$; $\delta_f = 20^{\circ}$; inboard and outboard stores on.

Figure 3.- Some model arrangements tested.

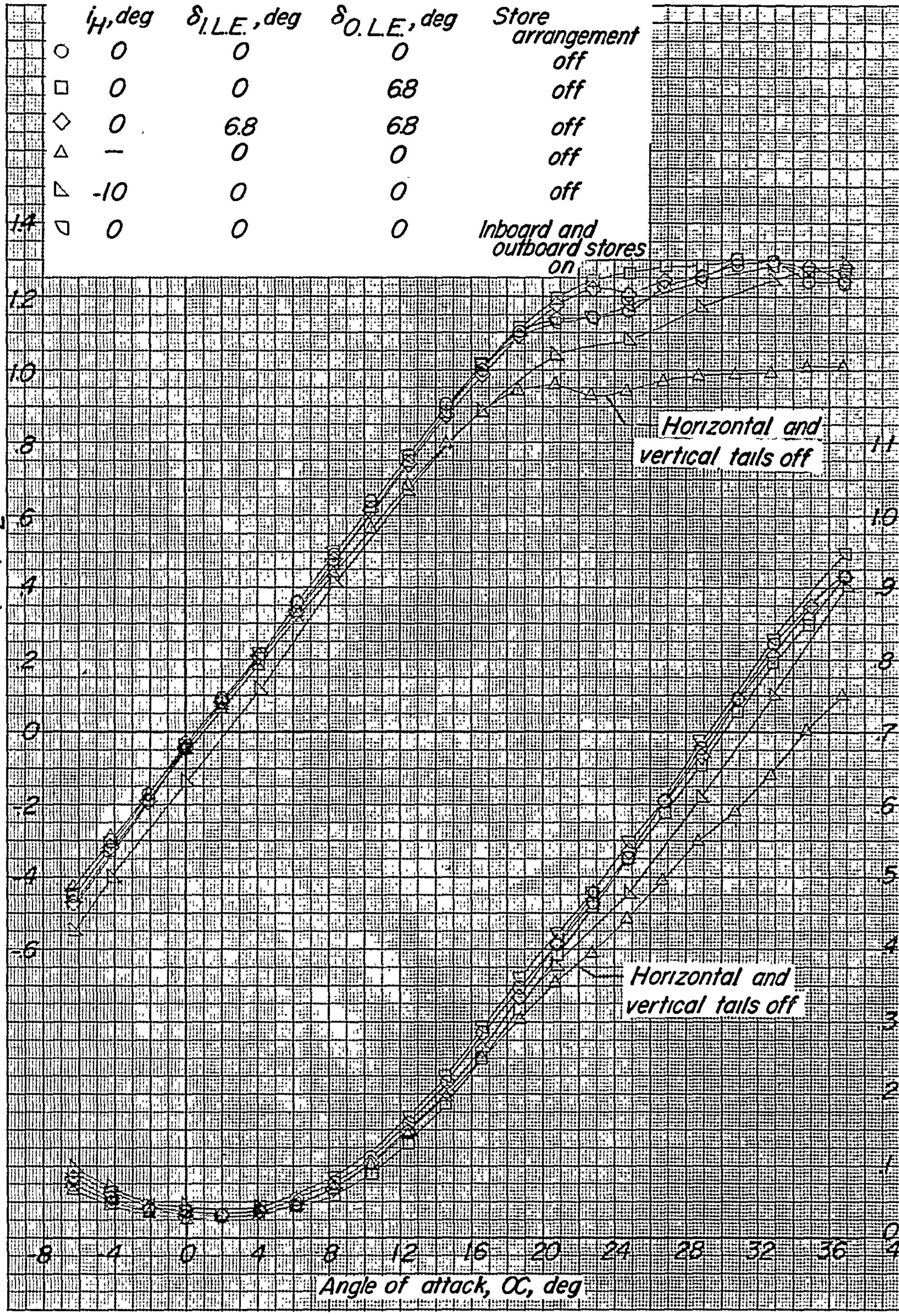

Figure 4.- Variation of C_L, C_D, and C_m with α for an 0.085-scale model of the Chance Vought XF8U-1 airplane. Clean configurations. Uncorrected for support-strut tares. $\delta_f = 0^{\circ}$.

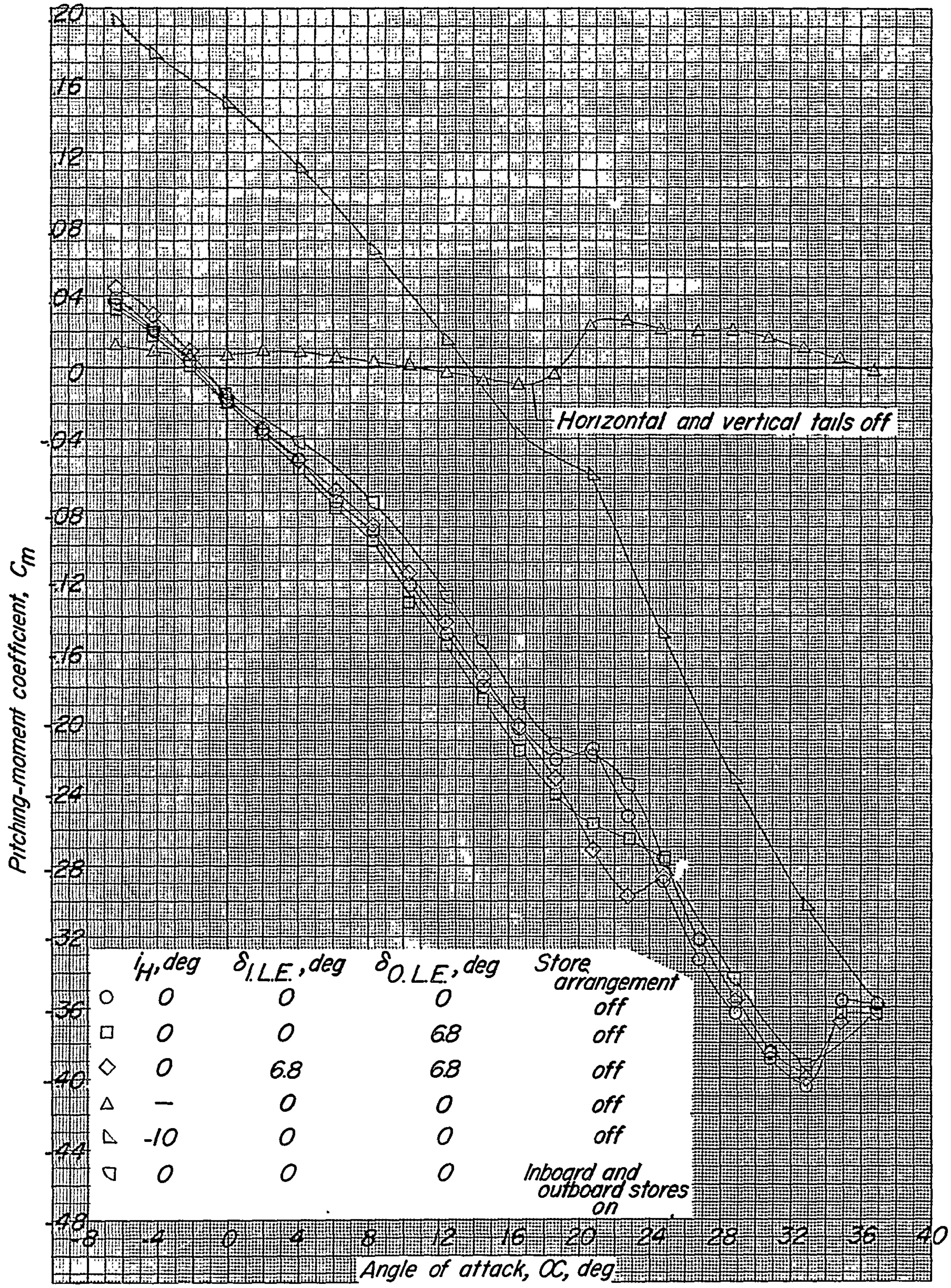

Figure 4.- Concluded.

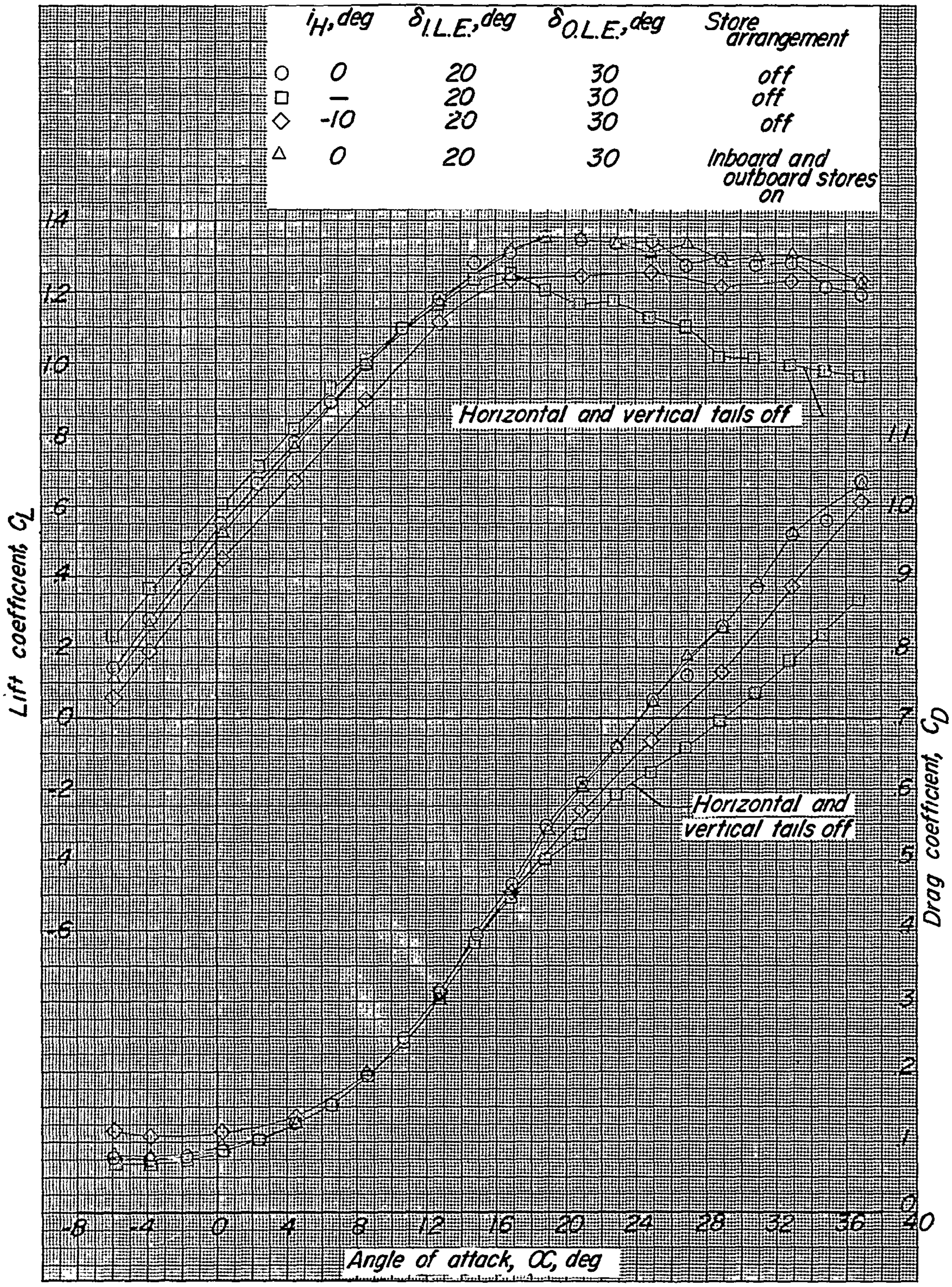

Figure 5.- Variation of C_L, C_D, and C_m with α for an 0.085-scale model of the Chance Vought XF8U-1 airplane. Landing configurations. Uncorrected for support-strut tares. $\delta_f = 20^{\circ}$.

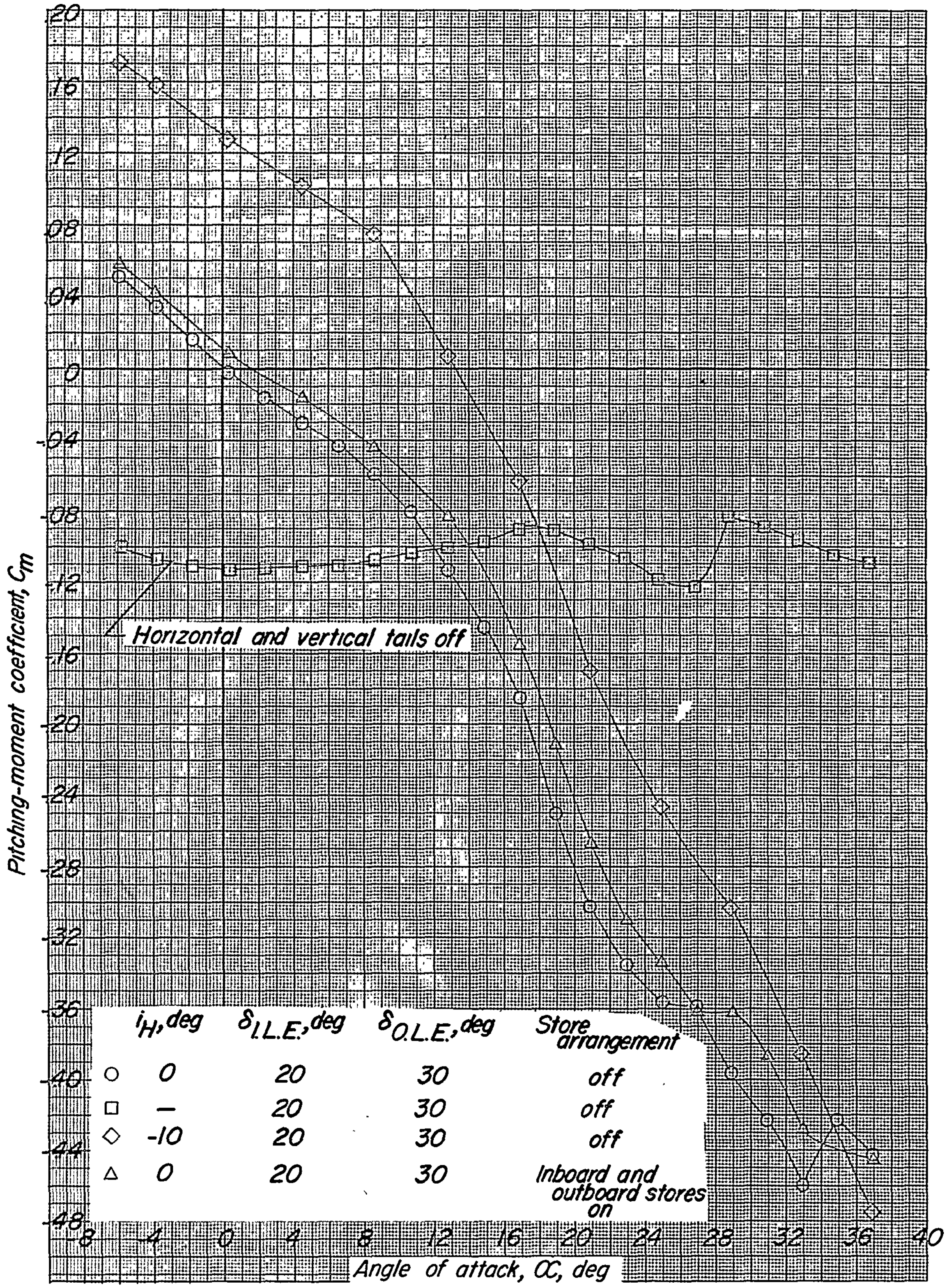

Figure 5.- Concluded.

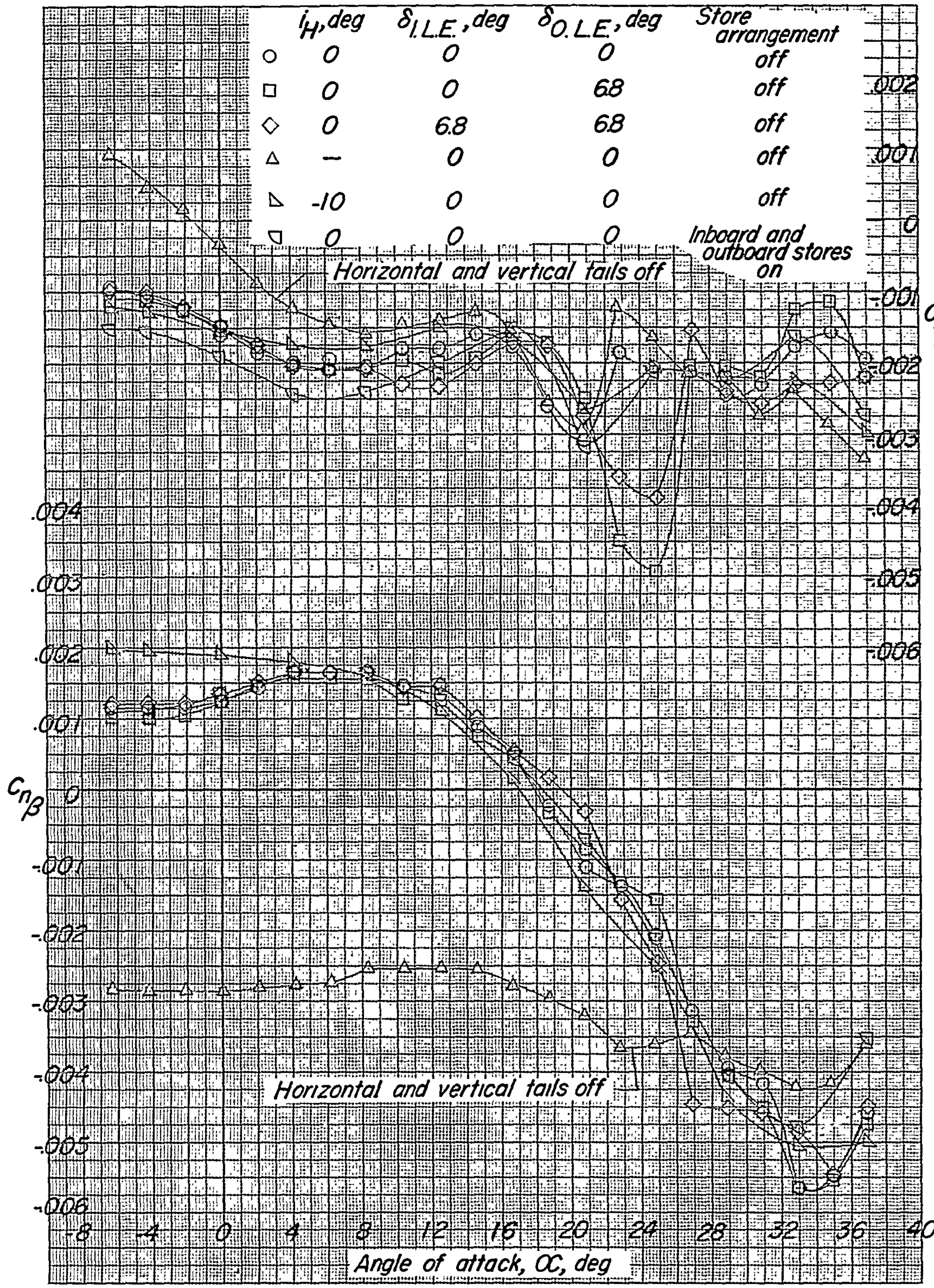

Figure 6.- Variation of C_{l_β}, C_{n_β}, and C_{Y_β} with α for an 0.085-scale model of the Chance Vought XF8U-1 airplane. Clean configurations. Uncorrected for support-strut tares. $\delta_f = 0^\circ$.

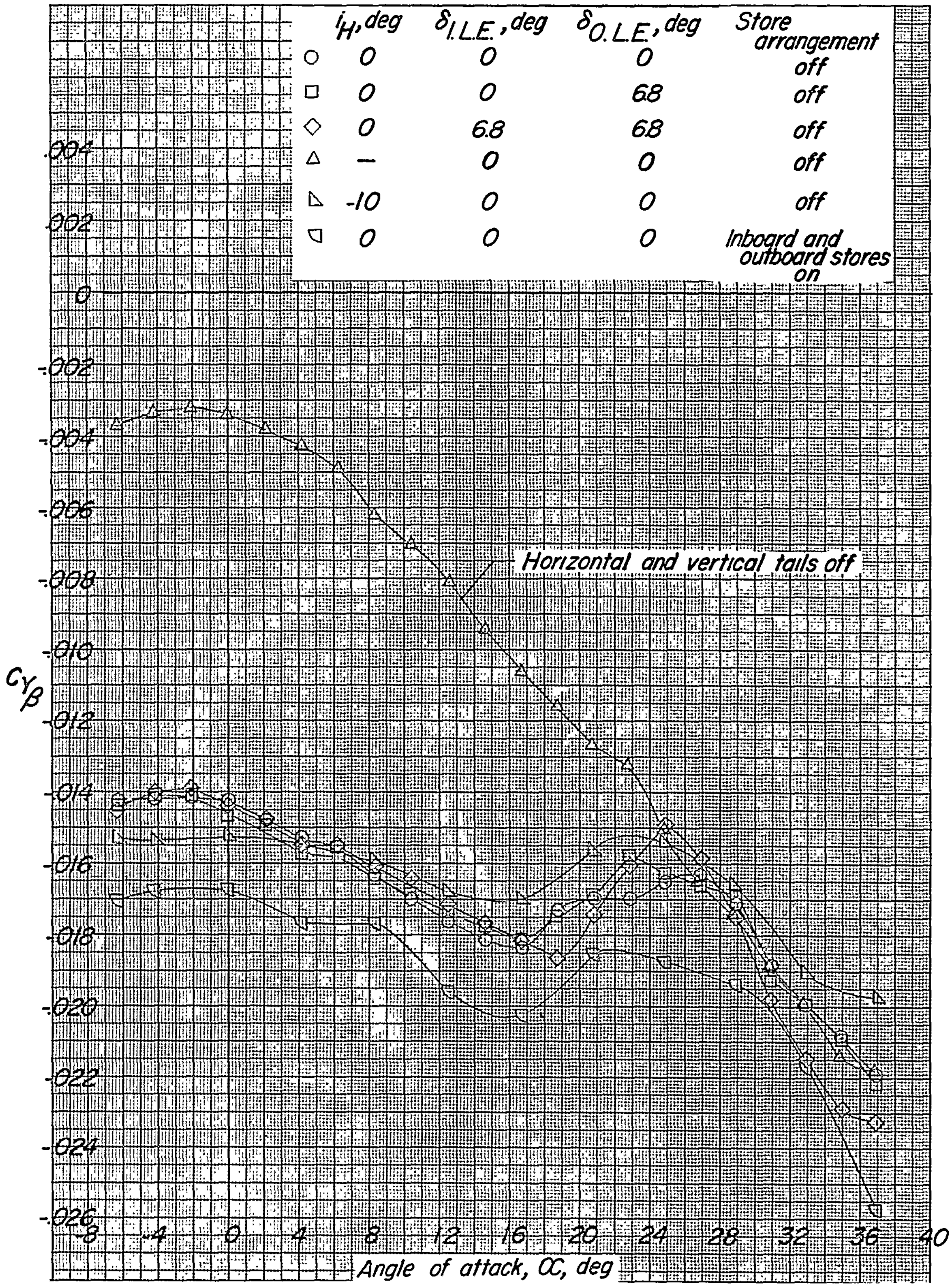

Figure 6.- Concluded.

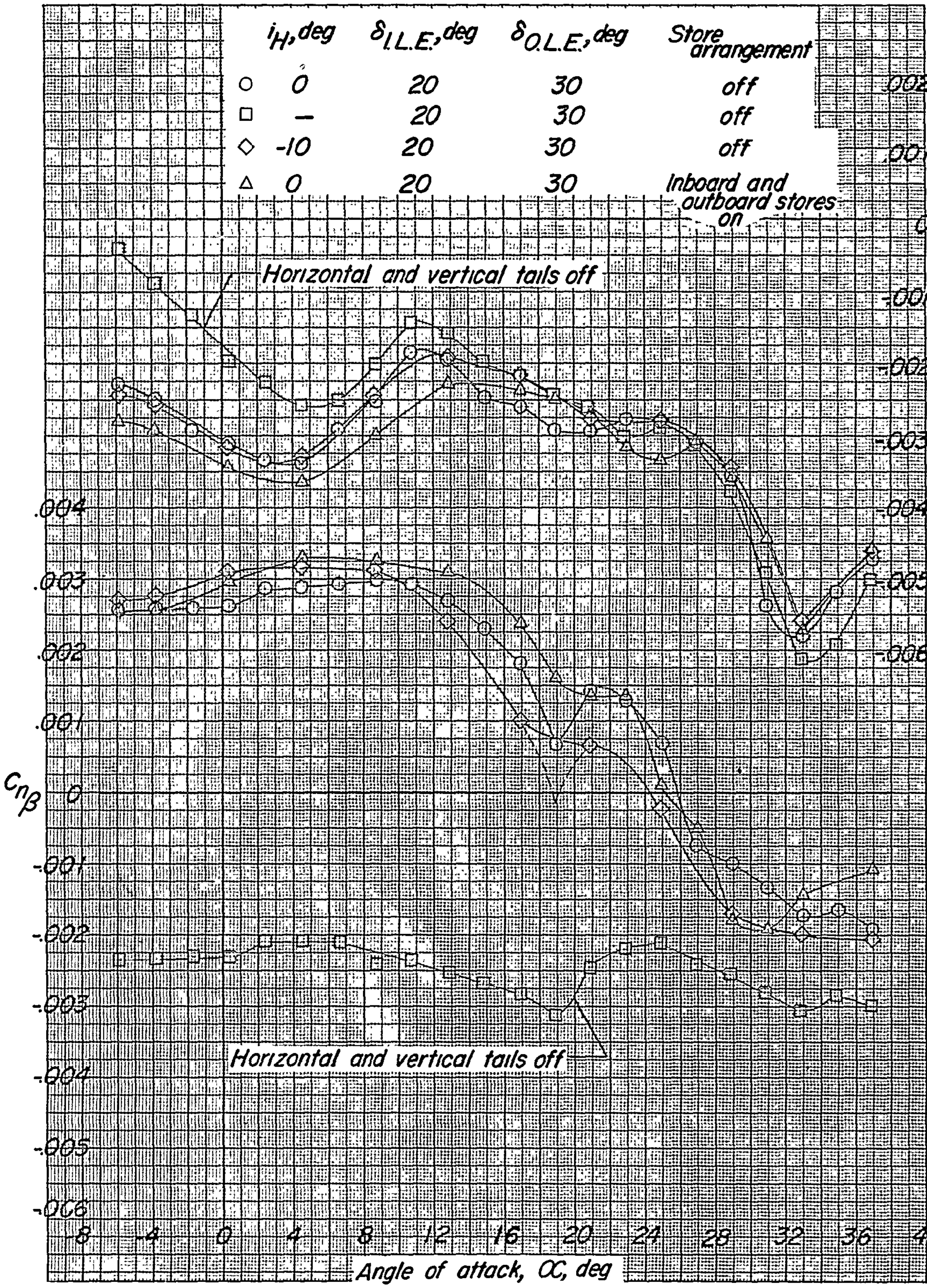

Figure 7.- Variation of C_{l_β}, C_{n_β}, and C_{Y_β} with α for an 0.085-scale model of the Chance Vought XF8U-1 airplane. Landing configurations. Uncorrected for support-strut tares. $\delta_f = 20^\circ$.

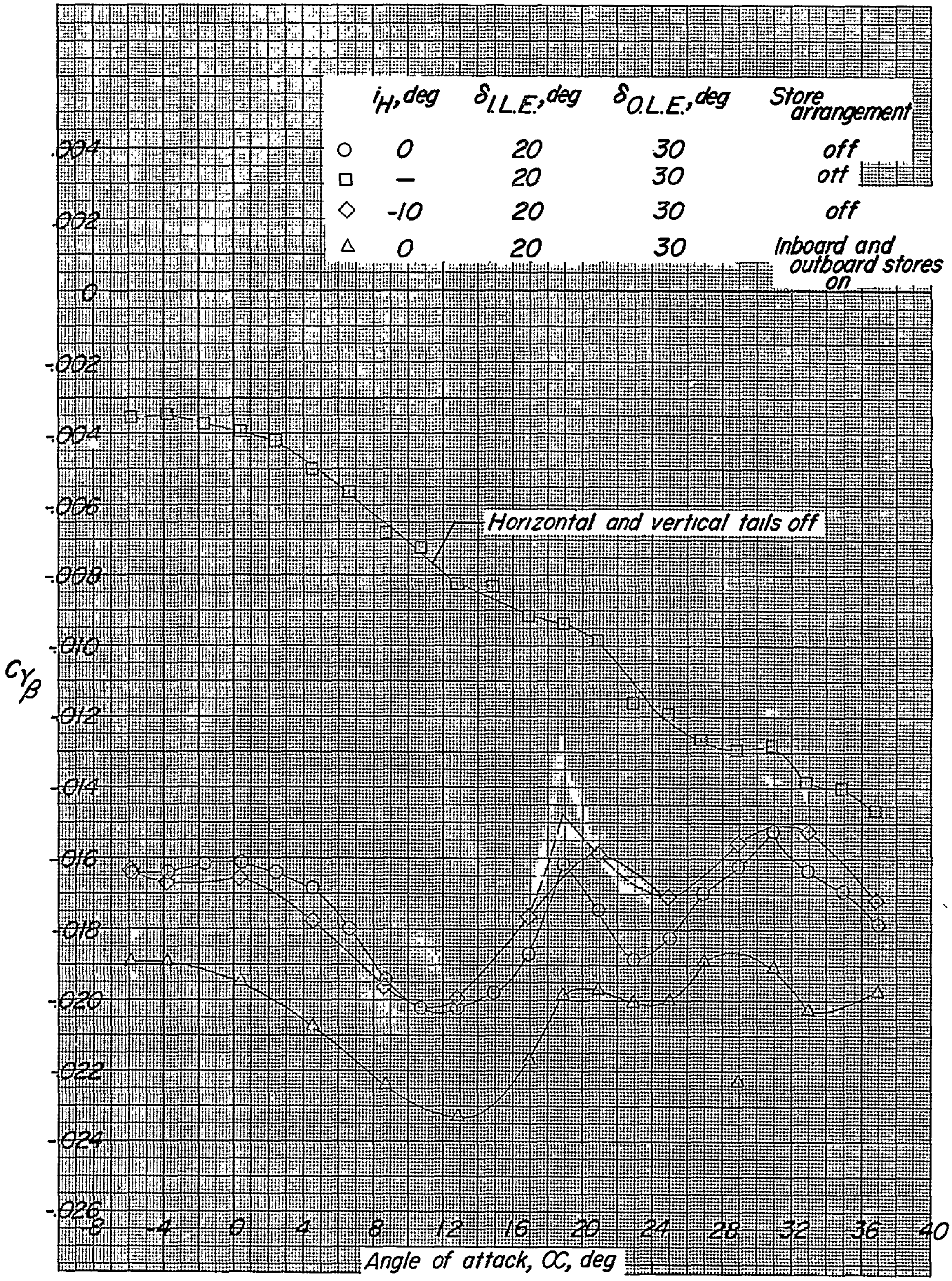

Figure 7.- Concluded.

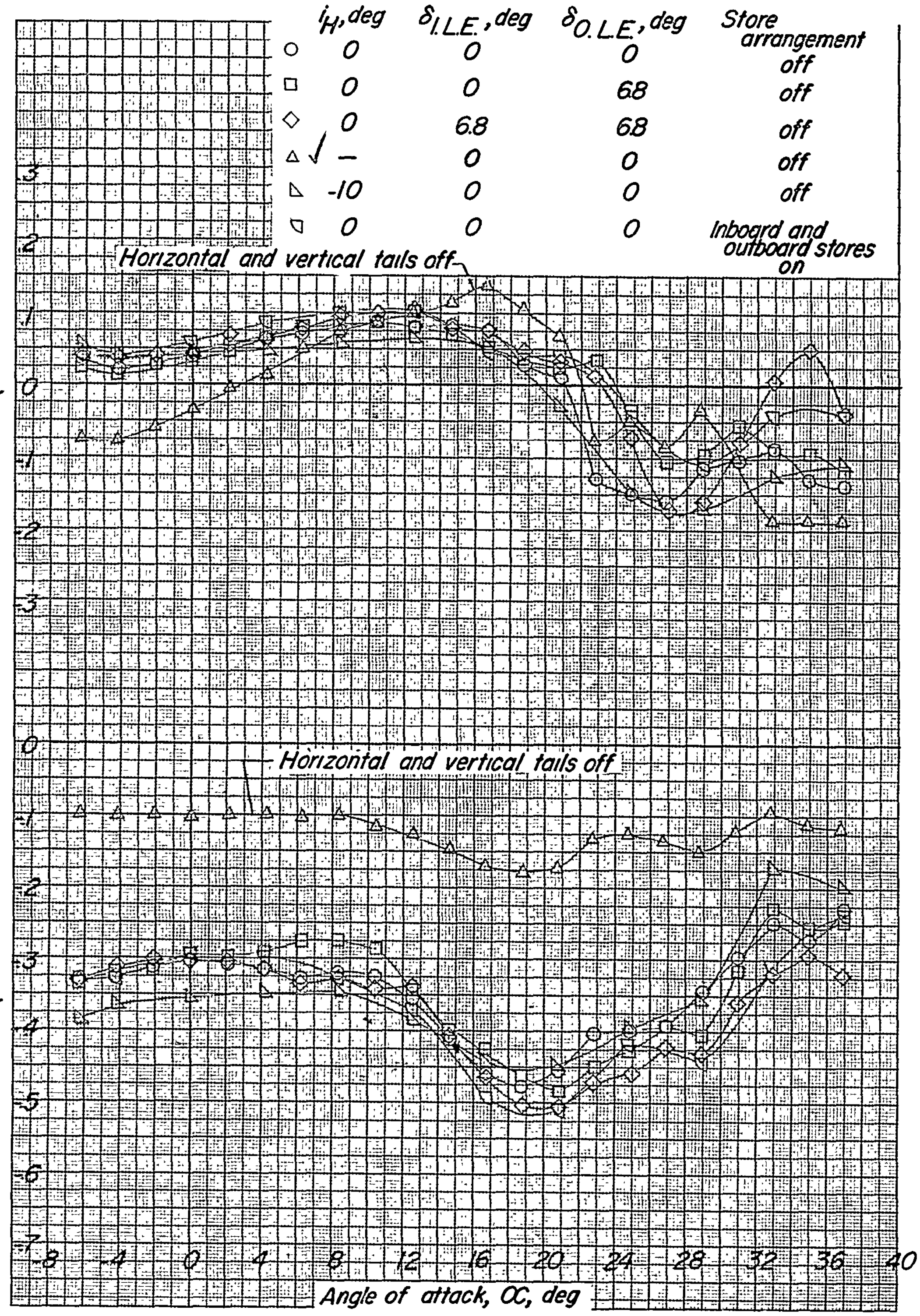

Figure 8.- Variation of C_{l_r}, C_{n_r}, and C_{Y_r} with α for an 0.085-scale model of the Chance Vought XF8U-1 airplane. Clean configurations. Uncorrected for support-strut tares. $\delta_f = 0^{\circ}$.

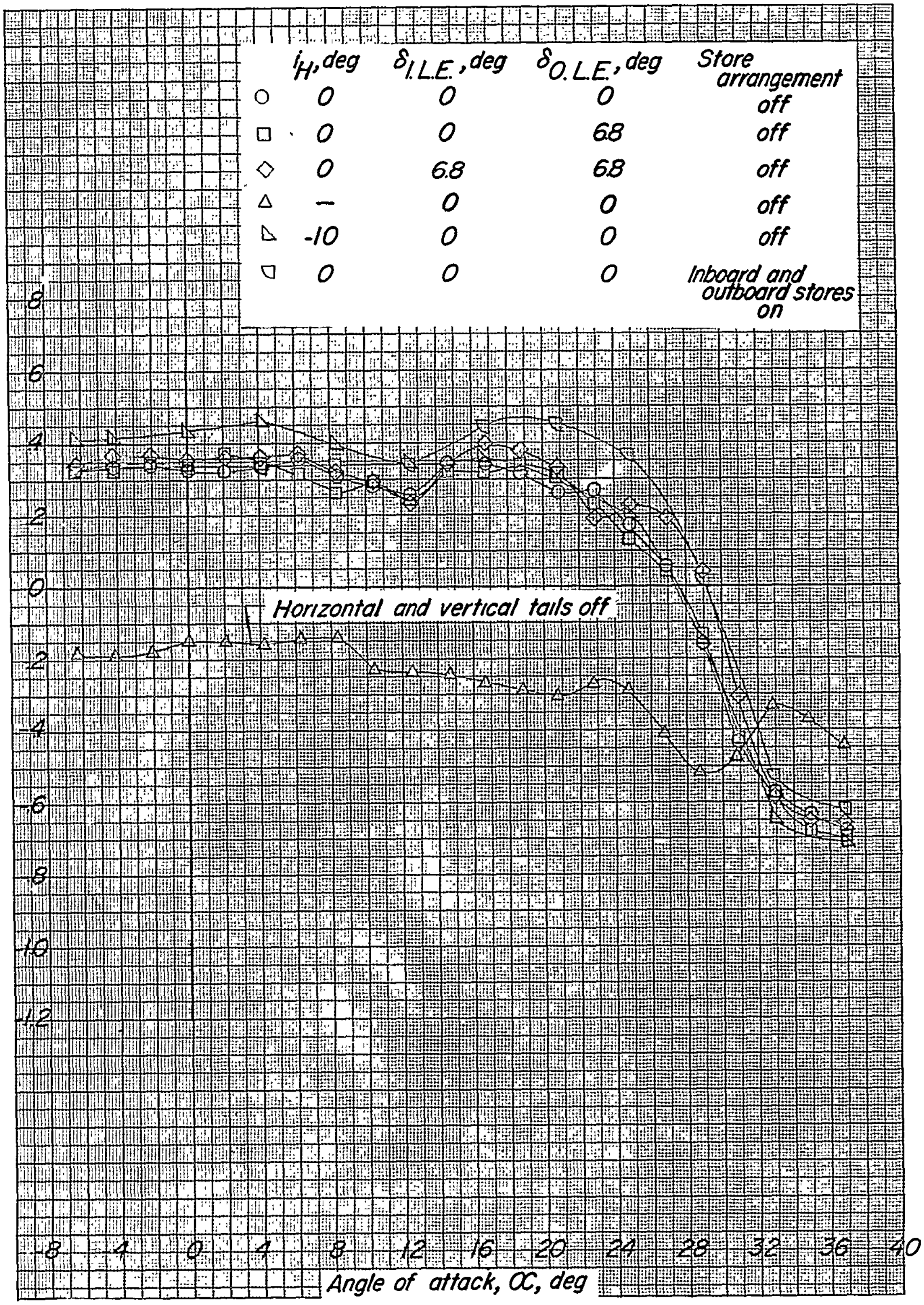

Figure 8.- Concluded.

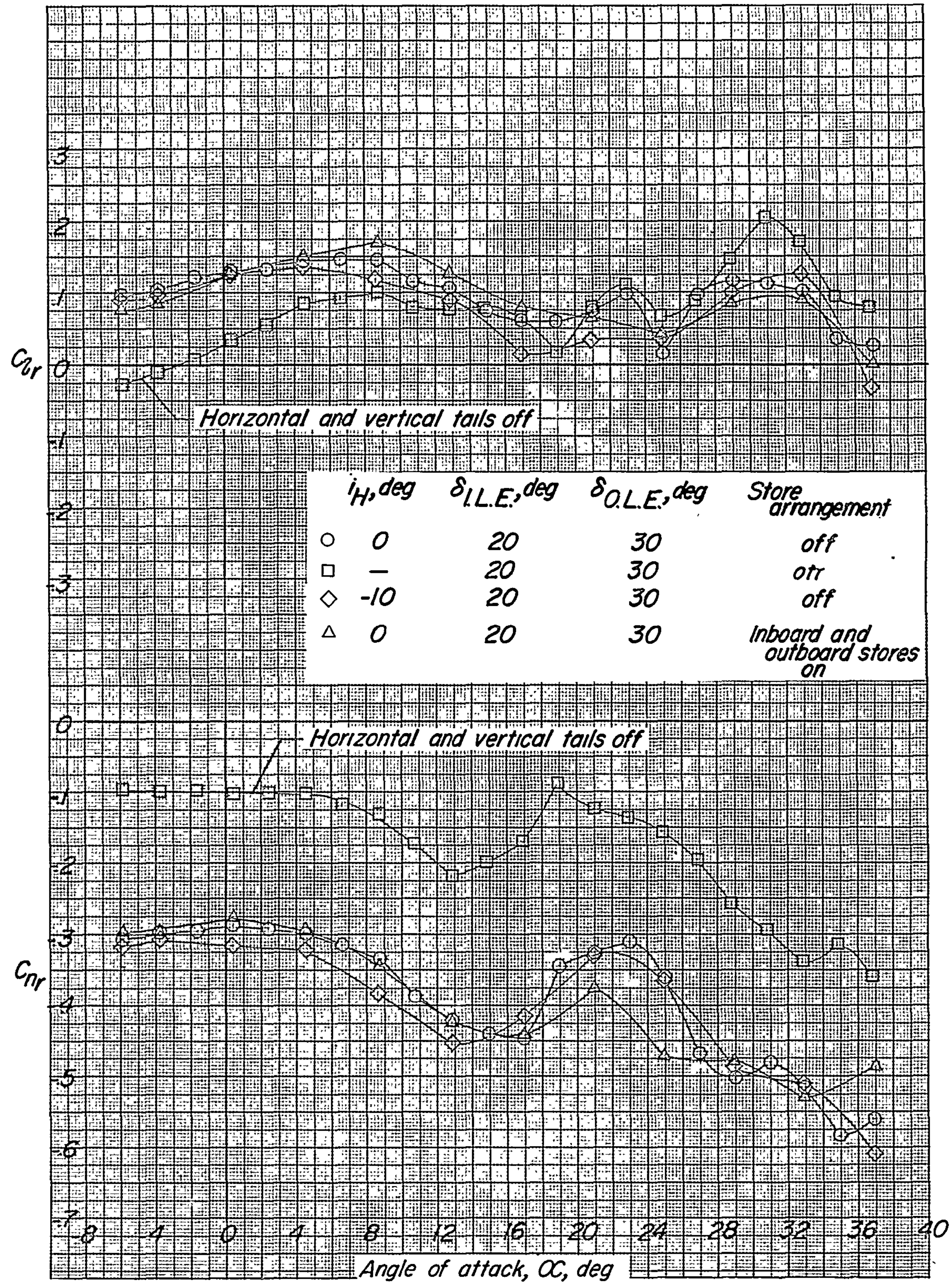

Figure 9.- Variation of C_{l_r}, C_{n_r}, and C_{Y_r} with α for an 0.085-scale model of the Chance Vought XF8U-1 airplane. Landing configurations. Uncorrected for support-strut tares. $\delta_f = 20^\circ$.

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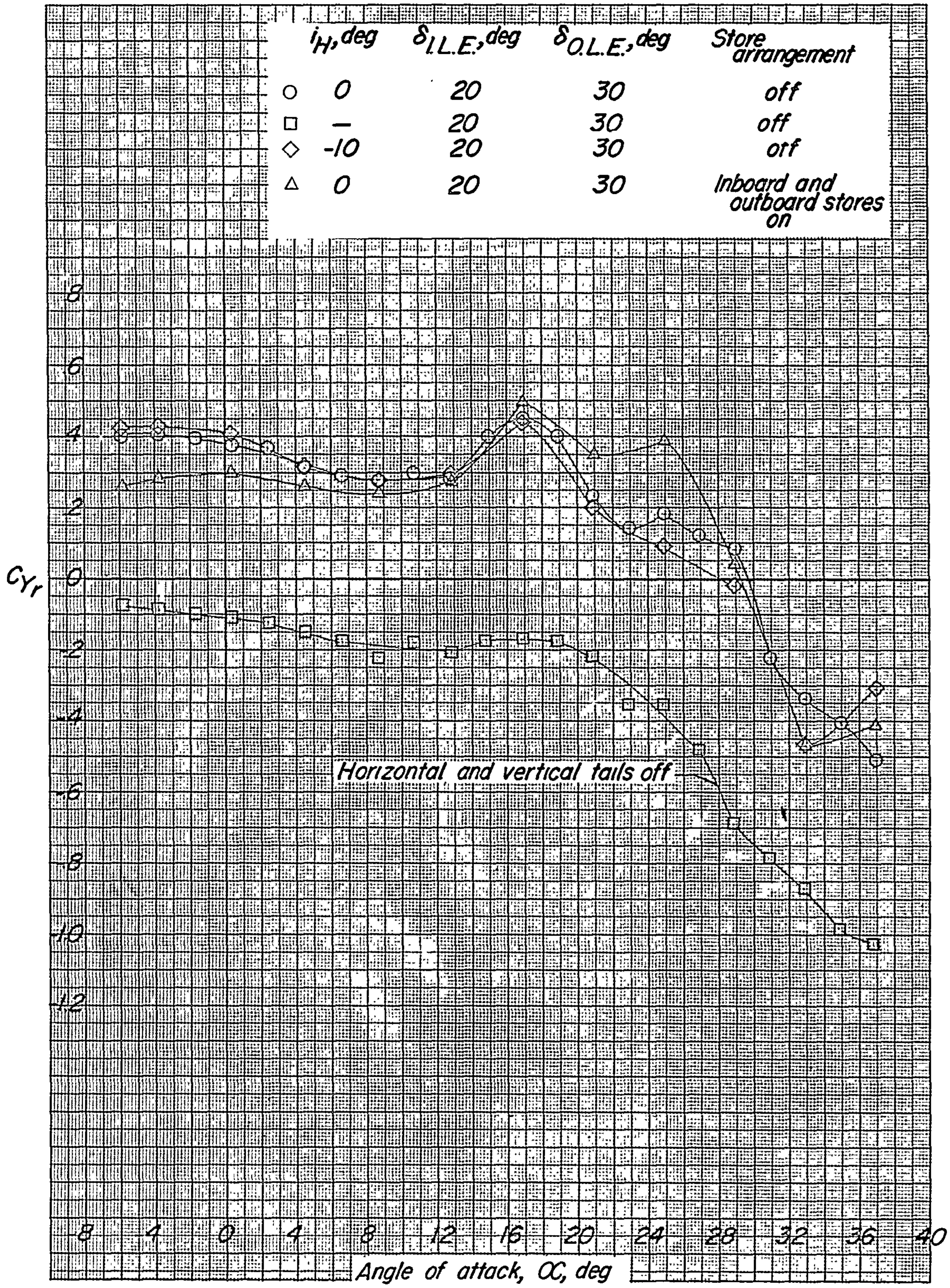

Figure 9.- Concluded.

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